

# INSTITUTE AND FACULTY OF ACTUARIES

## EXAMINATION

3 October 2012 (pm)

### Subject ST9 – Enterprise Risk Management

*Time allowed: Three hours*

#### **INSTRUCTIONS TO THE CANDIDATE**

1. *Enter all the candidate and examination details as requested on the front of your answer booklet.*
2. *You have 15 minutes before the start of the examination in which to read the questions. You are strongly encouraged to use this time for reading only, but notes may be made. You then have three hours to complete the paper.*
3. *You must not start writing your answers in the booklet until instructed to do so by the supervisor.*
4. *Mark allocations are shown in brackets.*
5. *Attempt all six questions, beginning your answer to each question on a separate sheet.*
6. *Candidates should show calculations where this is appropriate.*

#### **AT THE END OF THE EXAMINATION**

*Hand in BOTH your answer booklet, with any additional sheets firmly attached, and this question paper.*

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| <p><i>In addition to this paper you should have available the 2002 edition of the Formulae and Tables and your own electronic calculator from the approved list.</i></p> |
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**1** An industry is dominated by two companies: Company A which has a fully functioning ERM framework and Company B which does not have any formal ERM framework. Both companies make similar products and have the same potential client base.

(i) Discuss the potential justifications for the two companies' ERM strategies. [5]

(ii) Discuss the potential impact on Company A's share price if Company B were to introduce a fully functioning ERM framework. [3]

[Total 8]

**2** A small, poor and undeveloped country has appointed a European Solvency II expert to introduce similar risk-based regulation to the country's life and general insurance companies.

(i) Describe initiatives that the newly appointed expert could introduce which would have an immediate impact on the regulatory approach to the monitoring and measuring of an insurance company's financial risks. [7]

(ii) Describe other initiatives that the newly appointed expert could introduce which would help the insurance companies to prepare for the planned new regulation. [3]

The new regulatory framework has now been put in place.

As part of its implementation, a "whistleblowers' hotline" has been introduced. This allows persons to report breaches of the regulatory requirements to the regulator with guaranteed anonymity.

Unfortunately the regulator has been inundated with calls and all of them to date have been petty and/or malicious. The regulator therefore wishes to issue a set of guidelines regarding the future usage of this hotline, which would filter out petty and malicious reports and encourage the reporting of serious breaches.

(iii) Suggest appropriate guidelines for this purpose. [6]

(iv) Describe the process that the regulator should employ to administer, assess and resolve any reported breaches. [4]

[Total 20]

- 3 Southwest Re is a multinational reinsurance company that has successfully underwritten mortality and property risks for many years. The company has now decided to start insuring the operational risks of insurance companies.

(i) Define operational risk. [1]

Four of the existing clients of Southwest Re wish to insure their operational risk exposure. Each of these four insurance companies has been collecting operational loss data for several years and they have shared this data with Southwest Re so that the pricing team can calculate the premiums for one year's insurance cover.

The total annualised operational losses for the four insurance companies have the following statistical properties:

|                    | <i>Mean</i> | <i>Variance</i> |
|--------------------|-------------|-----------------|
| Cornwall Insurance | 20,000      | 250,000,000     |
| Devon Insurance    | 20,000      | 150,000,000     |
| Somerset Insurance | 10,000      | 40,000,000      |
| Dorset Insurance   | 40,000      | 600,000,000     |

The pricing team has no experience of calculating insurance premiums for operational risk. Two approaches have been proposed for further investigation:

#### **Approach I**

- Determine the insurance premium as the expected claim cost plus a 50% margin to cover the reinsurer's expenses and desired profit margin.

#### **Approach II**

- Fit a gamma distribution to the total operational losses using the method of moments.
- Calculate the standalone capital requirement using a Value at Risk (VaR) methodology consistent with a 1 in 200 loss (i.e. 99.5% confidence).
- Determine the insurance premium as the expected claim plus the cost of capital plus a 25% margin to cover the reinsurer's expenses and desired profit margin. The cost of capital is defined as 6% of the standalone capital requirement.

(ii) Calculate the insurance premiums under each approach for each of the four insurance companies, using the operational risk loss data provided above and the gamma distribution tables provided at the end of this examination paper. [7]

(iii) Discuss the advantages and disadvantages of each approach, including recommendations for improving the calculation of the insurance premium. [11]

Dorset Insurance believes that the insurance premium quoted by Southwest Re is too high and has decided not to purchase the insurance.

- (iv) Describe other options that might be available to Dorset Insurance to mitigate its various operational risks. [8]

Cornwall Insurance, Devon Insurance and Somerset Insurance all decide to purchase the insurance, which Southwest Re will underwrite in a newly created subsidiary.

- (v) (a) Calculate the capital requirement for the subsidiary using a VaR methodology (at 99.5% confidence), assuming that the operational risks for each of the three insurance companies are independent.
- (b) Hence calculate the diversification benefit derived from underwriting operational risks for the three insurance companies.
- (c) Comment on any implications of (b) for the calculation of the insurance premium.
- (d) Comment on the appropriateness or otherwise of the independence assumption.

[6]

[Total 33]

**4** ABC Mortgages is an A-rated mortgage lending company. It secures funding for a tranche of retail mortgages by borrowing cash in the wholesale capital markets. It uses this cash to provide mortgages to the public. When it has sold a sufficient number of mortgages these are packaged into a collateralised mortgage-backed security that ABC Mortgages then sells in order to repay the cash it has borrowed.

- (i) Describe the two types of “market risk” to which ABC Mortgages is exposed. [2]

Prepayment risk is the risk that a mortgage holder chooses to repay his mortgage early thereby reducing the profitability of the security.

- (ii) Explain why it may not be appropriate to treat prepayment risk as its own risk category. [2]

DEF Bank is a large, AAA-rated multinational retail bank which to date has no exposure to ABC Mortgage’s domestic economy. It decides to acquire ABC Mortgages in order to expand into this new market.

- (iii) Explain the likely impact of the acquisition on the profit margin of ABC Mortgages. [2]
- (iv) Outline the likely impact of the acquisition on DEF Bank’s risk profile. [4]
- (v) Give an example of a systemic risk event which could impact both the domestic business of ABC Mortgages and DEF Bank’s international operations. [1]

[Total 11]

- 5** XYZ Bank is a large multinational bank. As part of its employment strategy it provides its staff with life and health insurance cover. It has opted to insure these risks with a wholly owned captive insurance company. The captive then purchases reinsurance to transfer the risk to third party reinsurers.
- (i) Outline the advantages and disadvantages of providing the life and health insurance cover in this way. [3]
  - (ii) Explain why reinsurance may not remove all of the risk relating to this cover. [3]
  - (iii) Suggest actions which XYZ Bank could take to reduce the mortality and morbidity risks which are being insured. [4]
- [Total 10]
- 6**
- (i) Outline Solvency II's mandatory risk framework. [6]
  - (ii) List the six risk categories underlying the standard formula for the Solvency Capital Requirement. [3]
  - (iii) Give examples of key risk indicators (KRIs) for the risk categories in (ii). [3]
  - (iv) Explain the various internal and external stakeholders that would be interested in monitoring KRIs of a company on a regular basis. [3]
  - (v) Discuss whether a metric used as a key performance indicator can also be used as a KRI. [3]
- [Total 18]

### Information for Question 3

#### Tabulation of the 99.5th percentile for the gamma distribution

| Lambda | 1/4000 | 1/4500 | 1/5000 | 1/5500 | 1/6000 | 1/6500 | 1/7000 | 1/7500 | 1/8000 | 1/8500 | 1/9000 | 1/9500 | 1/10000 | 1/10500 | 1/11000 | 1/11500 | 1/12000 | 1/12500 | 1/13000 | 1/13500 | 1/14000 | 1/14500 | 1/15000 |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Alpha  |        |        |        |        |        |        |        |        |        |        |        |        |         |         |         |         |         |         |         |         |         |         |         |
| 1.500  | 25676  | 28886  | 32095  | 35305  | 38514  | 41724  | 44934  | 48143  | 51353  | 54562  | 57772  | 60981  | 64191   | 67400   | 70610   | 73819   | 77029   | 80238   | 83448   | 86658   | 89867   | 93077   | 96286   |
| 1.533  | 25957  | 29201  | 32446  | 35691  | 38935  | 42180  | 45424  | 48669  | 51914  | 55158  | 58403  | 61647  | 64892   | 68137   | 71381   | 74626   | 77871   | 81115   | 84360   | 87604   | 90849   | 94094   | 97338   |
| 1.567  | 26236  | 29515  | 32794  | 36074  | 39353  | 42633  | 45912  | 49192  | 52471  | 55751  | 59030  | 62309  | 65589   | 68868   | 72148   | 75427   | 78707   | 81986   | 85266   | 88545   | 91824   | 95104   | 98383   |
| 1.600  | 26513  | 29827  | 33141  | 36455  | 39769  | 43083  | 46397  | 49711  | 53025  | 56339  | 59653  | 62967  | 66281   | 69595   | 72910   | 76224   | 79538   | 82852   | 86166   | 89480   | 92794   | 96108   | 99422   |
| 1.633  | 26788  | 30136  | 33485  | 36833  | 40182  | 43530  | 46879  | 50227  | 53576  | 56924  | 60273  | 63621  | 66970   | 70318   | 73667   | 77015   | 80364   | 83712   | 87061   | 90409   | 93758   | 97106   | 100455  |
| 1.667  | 27062  | 30444  | 33827  | 37210  | 40592  | 43975  | 47358  | 50740  | 54123  | 57506  | 60889  | 64271  | 67654   | 71037   | 74419   | 77802   | 81185   | 84567   | 87950   | 91333   | 94716   | 98098   | 101481  |
| 1.700  | 27334  | 30750  | 34167  | 37584  | 41001  | 44417  | 47834  | 51251  | 54668  | 58084  | 61501  | 64918  | 68334   | 71751   | 75168   | 78585   | 82001   | 85418   | 88835   | 92251   | 95668   | 99085   | 102502  |
| 1.733  | 27604  | 31055  | 34505  | 37956  | 41407  | 44857  | 48308  | 51758  | 55209  | 58659  | 62110  | 65560  | 69011   | 72462   | 75912   | 79363   | 82813   | 86264   | 89714   | 93165   | 96615   | 100066  | 103516  |
| 1.767  | 27874  | 31358  | 34842  | 38326  | 41810  | 45295  | 48779  | 52263  | 55747  | 59231  | 62716  | 66200  | 69684   | 73168   | 76652   | 80137   | 83621   | 87105   | 90589   | 94073   | 97558   | 101042  | 104526  |
| 1.800  | 28141  | 31659  | 35177  | 38694  | 42212  | 45730  | 49247  | 52765  | 56283  | 59800  | 63318  | 66836  | 70353   | 73871   | 77389   | 80906   | 84424   | 87942   | 91459   | 94977   | 98495   | 102012  | 105530  |
| 1.833  | 28408  | 31959  | 35510  | 39061  | 42612  | 46163  | 49714  | 53265  | 56815  | 60366  | 63917  | 67468  | 71019   | 74570   | 78121   | 81672   | 85223   | 88774   | 92325   | 95876   | 99427   | 102978  | 106529  |
| 1.867  | 28673  | 32257  | 35841  | 39425  | 43009  | 46593  | 50177  | 53762  | 57346  | 60930  | 64514  | 68098  | 71682   | 75266   | 78850   | 82434   | 86018   | 89603   | 93187   | 96771   | 100355  | 103939  | 107523  |
| 1.900  | 28937  | 32554  | 36171  | 39788  | 43405  | 47022  | 50639  | 54256  | 57873  | 61490  | 65107  | 68724  | 72341   | 75959   | 79576   | 83193   | 86810   | 90427   | 94044   | 97661   | 101278  | 104895  | 108512  |
| 1.933  | 29199  | 32849  | 36499  | 40149  | 43799  | 47449  | 51098  | 54748  | 58398  | 62048  | 65698  | 69348  | 72998   | 76648   | 80298   | 83947   | 87597   | 91247   | 94897   | 98547   | 102197  | 105847  | 109497  |
| 1.967  | 29460  | 33143  | 36826  | 40508  | 44191  | 47873  | 51556  | 55238  | 58921  | 62603  | 66286  | 69968  | 73651   | 77334   | 81016   | 84699   | 88381   | 92064   | 95746   | 99429   | 103111  | 106794  | 110477  |
| 2.000  | 29721  | 33436  | 37151  | 40866  | 44581  | 48296  | 52011  | 55726  | 59441  | 63156  | 66871  | 70586  | 74301   | 78016   | 81731   | 85446   | 89162   | 92877   | 96592   | 100307  | 104022  | 107737  | 111452  |
| 2.033  | 29979  | 33727  | 37474  | 41222  | 44969  | 48717  | 52464  | 56212  | 59959  | 63706  | 67454  | 71201  | 74949   | 78696   | 82444   | 86191   | 89938   | 93686   | 97433   | 101181  | 104928  | 108676  | 112423  |
| 2.067  | 30237  | 34017  | 37797  | 41576  | 45356  | 49136  | 52915  | 56695  | 60475  | 64254  | 68034  | 71814  | 75593   | 79373   | 83153   | 86932   | 90712   | 94492   | 98271   | 102051  | 105831  | 109610  | 113390  |
| 2.100  | 30494  | 34306  | 38118  | 41929  | 45741  | 49553  | 53365  | 57176  | 60988  | 64800  | 68612  | 72423  | 76235   | 80047   | 83859   | 87670   | 91482   | 95294   | 99106   | 102918  | 106729  | 110541  | 114353  |
| 2.133  | 30750  | 34593  | 38437  | 42281  | 46125  | 49968  | 53812  | 57656  | 61500  | 65343  | 69187  | 73031  | 76874   | 80718   | 84562   | 88406   | 92249   | 96093   | 99937   | 103780  | 107624  | 111468  | 115312  |
| 2.167  | 31004  | 34880  | 38756  | 42631  | 46507  | 50382  | 54258  | 58133  | 62009  | 65884  | 69760  | 73636  | 77511   | 81387   | 85262   | 89138   | 93013   | 96889   | 100764  | 104640  | 108515  | 112391  | 116267  |
| 2.200  | 31258  | 35165  | 39073  | 42980  | 46887  | 50794  | 54702  | 58609  | 62516  | 66423  | 70331  | 74238  | 78145   | 82052   | 85960   | 89867   | 93774   | 97681   | 101589  | 105496  | 109403  | 113310  | 117218  |
| 2.233  | 31511  | 35450  | 39388  | 43327  | 47266  | 51205  | 55144  | 59083  | 63021  | 66960  | 70899  | 74838  | 78777   | 82716   | 86654   | 90593   | 94532   | 98471   | 102410  | 106349  | 110288  | 114226  | 118165  |
| 2.267  | 31762  | 35733  | 39703  | 43673  | 47644  | 51614  | 55584  | 59555  | 63525  | 67495  | 71465  | 75436  | 79406   | 83376   | 87347   | 91317   | 95287   | 99258   | 103228  | 107198  | 111168  | 115139  | 119109  |
| 2.300  | 32013  | 36015  | 40016  | 44018  | 48020  | 52021  | 56023  | 60025  | 64026  | 68028  | 72030  | 76031  | 80033   | 84035   | 88036   | 92038   | 96040   | 100041  | 104043  | 108044  | 112046  | 116048  | 120049  |
| 2.333  | 32263  | 36296  | 40329  | 44362  | 48395  | 52427  | 56460  | 60493  | 64526  | 68559  | 72592  | 76625  | 80658   | 84690   | 88723   | 92756   | 96789   | 100822  | 104855  | 108888  | 112921  | 116953  | 120986  |
| 2.367  | 32512  | 36576  | 40640  | 44704  | 48768  | 52832  | 56896  | 60960  | 65024  | 69088  | 73152  | 77216  | 81280   | 85344   | 89408   | 93472   | 97536   | 101600  | 105664  | 109728  | 113792  | 117856  | 121920  |

| Lambda | 1/4000 | 1/4500 | 1/5000 | 1/5500 | 1/6000 | 1/6500 | 1/7000 | 1/7500 | 1/8000 | 1/8500 | 1/9000 | 1/9500 | 1/10000 | 1/10500 | 1/11000 | 1/11500 | 1/12000 | 1/12500 | 1/13000 | 1/13500 | 1/14000 | 1/14500 | 1/15000 |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Alpha  |        |        |        |        |        |        |        |        |        |        |        |        |         |         |         |         |         |         |         |         |         |         |         |
| 2.400  | 32760  | 36855  | 40950  | 45045  | 49140  | 53235  | 57330  | 61425  | 65520  | 69615  | 73710  | 77805  | 81900   | 85995   | 90090   | 94185   | 98280   | 102375  | 106470  | 110565  | 114660  | 118755  | 122850  |
| 2.433  | 33007  | 37133  | 41259  | 45385  | 49511  | 53637  | 57763  | 61889  | 66015  | 70140  | 74266  | 78392  | 82518   | 86644   | 90770   | 94896   | 99022   | 103148  | 107274  | 111400  | 115525  | 119651  | 123777  |
| 2.467  | 33254  | 37410  | 41567  | 45724  | 49880  | 54037  | 58194  | 62351  | 66507  | 70664  | 74821  | 78977  | 83134   | 87291   | 91448   | 95604   | 99761   | 103918  | 108074  | 112231  | 116388  | 120544  | 124701  |
| 2.500  | 33499  | 37687  | 41874  | 46061  | 50249  | 54436  | 58624  | 62811  | 66998  | 71186  | 75373  | 79561  | 83748   | 87935   | 92123   | 96310   | 100498  | 104685  | 108872  | 113060  | 117247  | 121435  | 125622  |
| 2.533  | 33744  | 37962  | 42180  | 46398  | 50616  | 54834  | 59052  | 63270  | 67488  | 71706  | 75924  | 80142  | 84360   | 88578   | 92796   | 97014   | 101232  | 105450  | 109668  | 113886  | 118104  | 122322  | 126540  |
| 2.567  | 33988  | 38236  | 42485  | 46733  | 50982  | 55230  | 59479  | 63727  | 67976  | 72224  | 76473  | 80721  | 84970   | 89218   | 93467   | 97715   | 101964  | 106212  | 110461  | 114709  | 118958  | 123206  | 127455  |
| 2.600  | 34231  | 38510  | 42789  | 47068  | 51347  | 55626  | 59905  | 64183  | 68462  | 72741  | 77020  | 81299  | 85578   | 89857   | 94136   | 98415   | 102693  | 106972  | 111251  | 115530  | 119809  | 124088  | 128367  |
| 2.633  | 34474  | 38783  | 43092  | 47401  | 51710  | 56020  | 60329  | 64638  | 68947  | 73256  | 77566  | 81875  | 86184   | 90493   | 94802   | 99112   | 103421  | 107730  | 112039  | 116348  | 120658  | 124967  | 129276  |
| 2.667  | 34715  | 39055  | 43394  | 47734  | 52073  | 56412  | 60752  | 65091  | 69431  | 73770  | 78110  | 82449  | 86788   | 91128   | 95467   | 99807   | 104146  | 108485  | 112825  | 117164  | 121504  | 125843  | 130183  |
| 2.700  | 34956  | 39326  | 43695  | 48065  | 52435  | 56804  | 61174  | 65543  | 69913  | 74282  | 78652  | 83021  | 87391   | 91760   | 96130   | 100500  | 104869  | 109239  | 113608  | 117978  | 122347  | 126717  | 131086  |
| 2.733  | 35197  | 39596  | 43996  | 48395  | 52795  | 57195  | 61594  | 65994  | 70393  | 74793  | 79192  | 83592  | 87992   | 92391   | 96791   | 101190  | 105590  | 109990  | 114389  | 118789  | 123188  | 127588  | 131987  |
| 2.767  | 35436  | 39866  | 44295  | 48725  | 53154  | 57584  | 62013  | 66443  | 70873  | 75302  | 79732  | 84161  | 88591   | 93020   | 97450   | 101879  | 106309  | 110738  | 115168  | 119597  | 124027  | 128456  | 132886  |
| 2.800  | 35675  | 40135  | 44594  | 49053  | 53513  | 57972  | 62432  | 66891  | 71350  | 75810  | 80269  | 84729  | 89188   | 93647   | 98107   | 102566  | 107026  | 111485  | 115944  | 120404  | 124863  | 129323  | 133782  |
| 2.833  | 35913  | 40403  | 44892  | 49381  | 53870  | 58359  | 62849  | 67338  | 71827  | 76316  | 80805  | 85294  | 89784   | 94273   | 98762   | 103251  | 107740  | 112230  | 116719  | 121208  | 125697  | 130186  | 134675  |
| 2.867  | 36151  | 40670  | 45189  | 49708  | 54227  | 58745  | 63264  | 67783  | 72302  | 76821  | 81340  | 85859  | 90378   | 94897   | 99415   | 103934  | 108453  | 112972  | 117491  | 122010  | 126529  | 131048  | 135566  |
| 2.900  | 36388  | 40937  | 45485  | 50034  | 54582  | 59131  | 63679  | 68228  | 72776  | 77325  | 81873  | 86422  | 90970   | 95519   | 100067  | 104616  | 109164  | 113713  | 118261  | 122810  | 127358  | 131907  | 136455  |

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